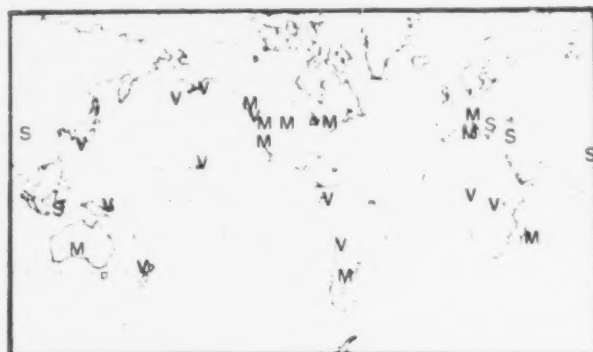


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SEAN

Scientific Event Alert Network

BULLETIN

21

VOLUME 11, NO. 8, AUGUST 31, 1986

M-Meteoritic S-Seismic V-Volcanic

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Lindsay McClelland, Elizabeth Nielsen, Marjorie Summers

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C. M. VL

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VOLCANIC EVENTS

Lake Nyos, NW Cameroon (6.44°N, 10.3°E).

During the evening of 21 August a toxic gas cloud emerged from a lake within a young volcanic crater in NW Cameroon, killing more than 1700 people and uncounted numbers of animals. Lake Nyos is about 1400 m long, 900 m wide, and 220 m deep. Lava fountain deposits and a basaltic flow are exposed along the NE rim of the lake, and pyroclastic deposits that include abundant peridotites are on the N and E flanks. Scientists investigating the disaster suggested that the lake may represent a recent diatreme (Devine and others, 1986). The crater is located on the northern boundary of the NE-trending Cameroon volcanic Line, a zone of crustal weakness containing Triassic to Recent, generally alkaline volcanoes (figure 1). One active volcano, Mt. Cameroon (275 km SSW of Nyos), erupted October-November 1982 (see SEAN Bulletin v. 7, nos. 10-11) and CO₂ gas from Lake Monoun (about 100 km ESE of Nyos) killed 37 people in August 1984 (Sigurdsson et al., in press; and SEAN Bulletins v. 9, no. 8 and v. 10, no. 8).

Figure 1: Map showing location of Lake Nyos within the Cameroon Volcanic Line, after Fitton, J.G., 1980, The Benue Trough and Cameroon Line - A Migrating Rift System in West Africa; Earth and Planetary Science Letters, v. 51, p. 132-138.

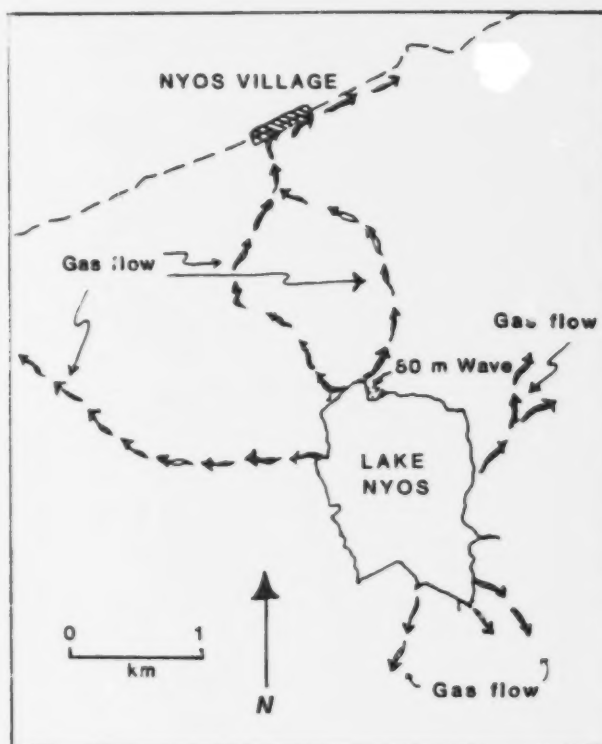


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Lake Nyos (continued)

Scientists interviewed many of the survivors (more than 300 were hospitalized), and took gas and water samples from the lake and streams. Medical and geological investigations suggest that victims were suffocated by CO_2 gas; there was no evidence that HCN or CO were present. Many survivors reported that the odor of gunpowder or rotten eggs permeated the area for about 2 days after the event and many had chemical burns on their skin (Koenigsberg et al., 1986). Positions of dead animals suggested that the gas cloud remained 100 m above of the lake surface as it moved out of the crater over low spots in the rim. The CO_2 -laden cloud blanketed low areas around the lake. Some of the cloud moved northward over the outflow, followed 2 stream valleys for about 1 km, then turned NE along a larger river valley and through the village of Nyos, asphyxiating most of the inhabitants in the area (figure 2). Gas that flowed W from the lake followed the Cha valley for about 25 km, causing many casualties. Portions of the gas cloud had enough density and velocity to knock down corn and banana plants in a few areas as it moved outward. Gas clouds also moved to the south along the inflow streams, spreading over a wide area, and over the E rim into a low-lying pocket.

Figure 2: Sketch map showing the paths taken by gas flowing from Lake Nyos.



Prior to the event, Lake Nyos had been clear, with no history of fish living in it, but afterward the upper 10 m was red/brown in color, and the water had a high CO_2 content. No gas bubbles had been observed before the event, nor were there reports of earthquakes. Immediately preceding the event, however, bubbling and low rumblings were heard by a few people living close to the lake. One witness saw a cloud that appeared to be luminous suspended above the lake for a time. Another witness observed a large surge of water wash onto a small peninsula on the N side of the lake, and F. LeGuern later measured its height at 80 meters above the lake. Along the E shore the surge height reached about 25 m and water had overflowed the natural spillway to the N by about 6 m. One helicopter pilot reported a white powder coating

Lake Nyos (continued)

the leaves and cliffs around the lake on 22 August, but it was washed away by rain before it could be collected.

After the emergence of the cloud, the lake level dropped until 24 August. CO₂ apparently continued to emanate from the lake water for several days after the event, as people collapsed at low-lying stream crossings.

A preliminary survey, using a small depth-finder, shows that the lake bottom drops off sharply from about 40 m to a flat crater floor at 220 m. Two shallow channels 15 m deep and 100 m wide extend from the base of the inflow streams and join about 500 m from the shore. The depth survey revealed no evidence of bottom sediment disruption but could not define small structures at 220 m depth. The lake temperature was nearly uniform with surface water at 22°C and bottom water at 23°C. Bicarbonate content of the water was high (722 mg/l) and the pH was about 5.15. The surface water was well oxygenated, but anoxic below 10 m. Water samples were taken at 50, 100, and 150 m; deep water samples effervesced as they were brought to the surface, losing as much as 1/3 of their volume. The water was clear at depth with a high iron content that formed a reddish precipitate when exposed to air. Sediments dredged from the lake bottom were clastic, dark brown in color, and had no sulfurous smell.

The source of the gas and the mechanism that triggered its release from the lake remain uncertain. The U.S. scientific team noted that: 1. There is no evidence for a direct volcanic or seismic trigger for the event; however, the nearest seismograph is 150 km to the SW. 2. Sudden injection of hot volcanic gas through the lake bottom or sudden release of a magmatic gas bubble trapped beneath bottom sediments appear unlikely, since the lake water temperature was low and uniform after the event, and there was no evidence that bottom sediments had been recently disrupted. 3. Slow seepage of low-temperature CO₂-rich magmatic gas into the lake could have culminated in a catastrophic gas ejection when solubility limits of bottom water were exceeded. 4. If the lake had previously been stratified (cooler, denser bottom water underlying a warmer surface layer), mixing or overturn could have brought gas-saturated water from depth to the surface. The resulting pressure drop would then have triggered a rapid gas release. Surface water temperatures are cooler during the rainy season, reducing density contrasts and therefore decreasing the stability of the lake's stratification. Turbulence generated by winds, waves, or a landslide might have triggered an overturn, but no evidence was found for a landslide into the lake.

During the dry season, the level of Lake Nyos drops, but during the rainy season (May-September), a 60-m waterfall develops at the outflow. The waterfall spills over a natural dam of pyroclastic deposits, the top 20 m of which are weakly consolidated. Leakage through the dam, even during the dry season, suggests that it is unstable and poses a hazard to residents in the valley.

George Kling, a member of the scientific team, identified 31 crater and maar lakes in NW Cameroon. Many are young and some appear to have formed within the past thousand years. Of the 17 lakes that Kling was able to sample, only Lake Nyos and Lake Monoun contained significant quantities of dissolved CO₂. No record of gas emission is known before the 1984 event at Lake Monoun, but no efforts have yet been made to explore the rich oral history of the region.

References: Devine, J.D., Lockwood, J.P., Compton, H.R., Evans, W.C., Kling, G., and Tuttle, M.L., 1986, Preliminary Report on the Lake Nyos Disaster by the United States Scientific Team Representing the Agency for International Development's Office of U. S. Foreign Disaster Assistance, 14 pp.

Lake Nyos (continued)

Koenigsberg, E., Clark, M., Wagner, G., and De Cata, S., 1986, Preliminary Report on the Lake Nyos Disaster by the U. S. Medical Team Representing the Agency for International Development's Office of U. S. Foreign Disaster Assistance, 1 p.

Sigurdsson, H., Devine, J.D., Tchoua, F.M., Presser, T.S., Pringle, M.K.W., and Evans, W.C., 1986, Origin of the Lethal Gas Cloud from Lake Monoun, Cameroon; Journal of Volcanology and Geothermal Research, in press.

Information Contacts: Joseph D. Devine, Department of Geological Sciences, Brown University, Providence, Rhode Island 02912 USA; John P. Lockwood, USGS Hawaiian Volcano Observatory, P.O. Box 51, Hawaii National Park, Hawaii 96718 USA; Harry R. Compton and Alan M. Humphrey, Environmental Protection Agency, 401 M St. SW, Washington, DC 20460 USA; William C. Evans, USGS, 345 Middlefield Rd., Menlo Park, California 94025 USA; George Kling, Department of Geology, Duke University, Durham, North Carolina 27708 USA; Michelle Tuttle, USGS, Denver Federal Center, Denver, Colorado 80225 USA.

Nyamuragira Volcano, E Zaire (1.38°S, 29.20°E). All times are local (= GMT + 2 hours).

An eruption began on 16 July at 1135 from a SSW flank fissure about 1.5 km long. The fissure trended SW-NE (the orientation of the regional rift axis) and was located at 2250 m altitude, 3.5 km SW of the S edge of the caldera, between the 3 small cones formed during the 1938 (Tschambene) eruption. A pair of lava fountains 200-250 m high emerged from the fissure, building an elongate cinder cone 150 m high, with a breached crater. Lava flowed to the SSW, around the W side of Shove cone, then continued SW, advancing 17 km in 2 weeks before stopping 2 km N of the Goma-Sake road. At the end of July, continuous fountaining ended and activity declined to intermittent strombolian explosions, then stopped for about 24 hours on 1 August.

The eruption resumed on 2 August at about 1700, producing a lava fountain 150 m high. A small lava lake filled the crater and cascaded over the S wall of the cone. Minor overflows formed a small lava field, with lava flowing in tubes near the cone, but the main flow had stagnated. Activity briefly declined on 7 August and stopped for 12 hours on the 8th, then a new lava fountain developed the next day. Some strong phreatomagmatic explosions occurred from the previously active vent. Six or seven blocks of lava as large as 100 m across floated on top of the flowing lava, moving downslope at about 2 m per hour. A slow decline in activity began on 13 August, but continued from 3 small strombolian vents until the eruption stopped. Since 21 August, only fumarolic activity has been observed.

Lava volume was estimated at $150-200 \times 10^6 \text{ m}^3$. In hand specimen, the lava appeared to be a typical Nyamuragira hawaiiite.

Information Contacts: Maurice Krafft, Centre de Vulcanologie Vulcain, B.P. 5, 68700 Cernay, France; Jacques Durieux, Groupe d'Etude des Volcans Actifs, 30 Rue H. Barbusse, 69008 Lyon, France.

Augustine Volcano, southwest Alaska, (59.37°N, 153.42°W). All times are local (= GMT - 8 hours).

The following is from Juergen Kienle. "Augustine was in moderate eruption from about 19-31 August. Renewed dome growth resulted in intense pyroclastic flow activity and plumes rose to 2500-3000 m. On 28 August, Maurice and Katia Krafft and

Augustine Volcano (continued)

Juergen Kienle observed many pyroclastic flows at close range. Incandescent samples of a newly extruded spine were collected by Tom Miller and Kienle on 11 September. The following is a summary of preliminary field observations.

"1. Observations from overflights and fishing boats: Bill DeCreft, a local bush pilot, reported ash in the air during the evening of 19 August, with unusually pink sunsets. The onset of activity coincided with the full moon, the peak range of the fortnightly earth and ocean tides. On 20 August, DeCreft observed 2 new pyroclastic flow lobes extending 3/4 of the way down the N and NE flanks. Light brown dust was trailing SE to Cape Douglas, 50 km away. Other pilots reported plumes to 3000 m. That evening (2030-2100), the crew of a fishing boat NW of the volcano observed incandescent pyroclastic flows descending the northern flanks of the volcano. At noon the next day, Tom Miller overflew the mountain and reported very modest ash emissions to a few hundred meters above the vent.

"Poor weather prevented observations 22-23 August, when ash and muddy rain fell at Homer, 100 km to the E. Glow was seen from a fishing boat on 25 August. Miller overflew the volcano again 27-28 August, observing pyroclastic flows and small eruption clouds that rose to 1000-2000 m above the volcano. The summit was partially obscured by orographic clouds.

"2. Seismicity: Figures 3 and 4 show daily surface events (pyroclastic flow events) and earthquakes ($\geq M_L 0.25$), March-September 1986. Earthquake activity had declined dramatically since the end of the major 27 March-early May eruptive phase. From May through August, seismicity has been very low; we typically recorded fewer than 5 events per day, occasionally up to 20 events per day. No buildup of seismicity preceded the present dome growth episode. However, it should be noted that during periods of intense avalanching or pyroclastic flow activity, the seismic background noise is so high that we cannot recognize individual microearthquakes.

"Throughout the summer, Merapi-type pyroclastic flows or rockfall avalanches occurred at a rate of less than 10 per day. Starting on 13-14 August, we noticed a decided increase in surface events, with more than 50 events counted daily between 21 and 31 August. As of 13 September, the surface event activity had declined to the low summer background level.

"3. Pyroclastic Flows: On 28 and 29 August, Maurice and Katia Krafft and Juergen Kienle visited Augustine island. On 28 August, the ash plume reached about 2500 m and prevailing winds carried it to uninhabited areas NW of the volcano. The entire W, N, and E slopes were heavily covered with wet ash all the way to the beach. Leaves and wildflowers were wilted brown from heavy ash accumulation and passage of SO_2 clouds. During the day, we managed to observe many pyroclastic flows at close range; figure 5 shows one descending the N flank around noon. Usually, pyroclastic flow activity followed intense rock avalanches high on the dome. Unfortunately, the dome was obscured by clouds and we could not see the rockfalls but they were distinctly audible. On one occasion, we clearly felt a strong pressure pulse preceding the emergence of a pyroclastic flow from under the clouds. The pulse followed intense rockfall activity. We interpret the pressure pulse as a vesiculation event on the dome when fresh magma became exposed at the surface after a rock avalanche. The pyroclastic flows essentially free-fall off the very steep dome. At Hell's Gate (at the base of the 1500-m-high dome, 1500 m horizontally from the source) speed was 40 m per second (observation by Maurice Krafft). Farther downslope, the flows decelerated rapidly and stopped at about 250 m altitude, 2.2 km horizontal distance from the source. There were 2 principal avalanche tracks down the northern flanks.

Augustine Volcano (continued)

Figure 3: Number of surface events (rock avalanches and pyroclastic flows) with durations greater than 1 minute on the highest station on Augustine (AUH), 800 m horizontally from the vent. For this figure, saturation level was set at 50 events per day. Plot by John Power.

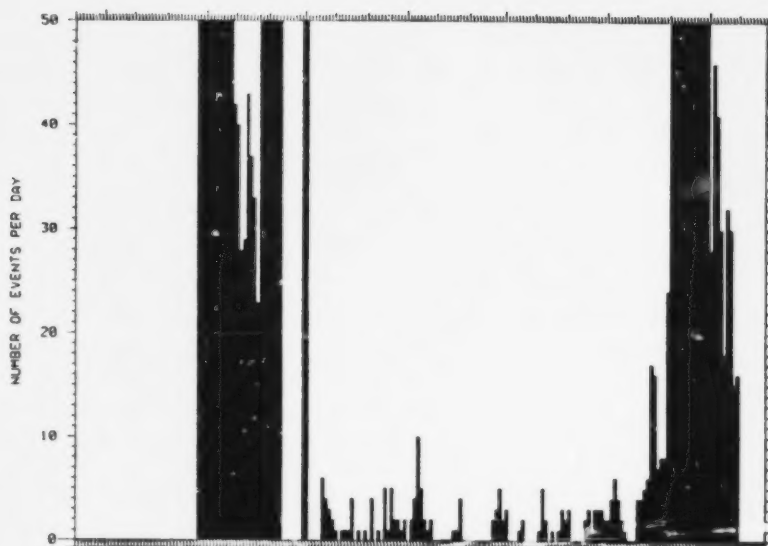
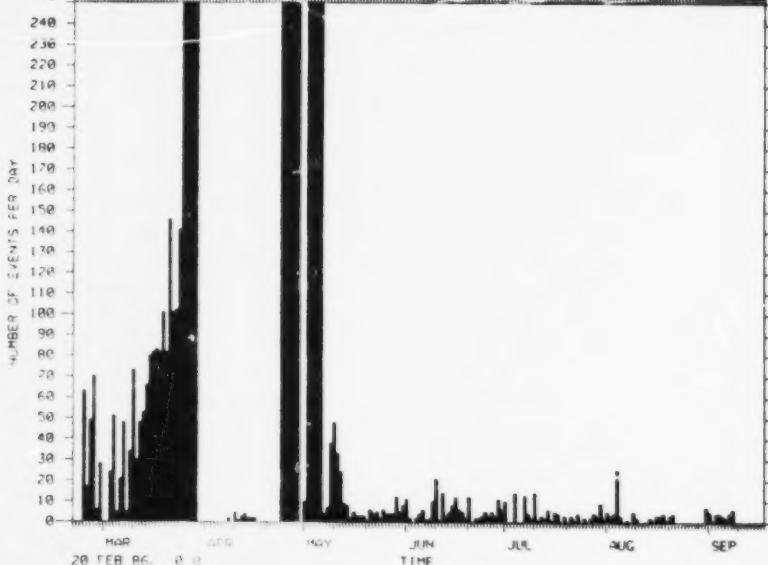


Figure 4: Number of earthquakes per day greater than magnitude (M_s) 0.25 as recorded at station AUH. The April gap occurred during intense surface activity, which masked individual microearthquakes. Plot by John Power.



"We were able to verify several of Frank Perret's important observations on pyroclastic flows (from Mt. Pelée in 1929-32). 1. The pyroclastic flows moved in silence, unheard even from very close range (50-200 m). This is in striking contrast to the loud rattle of rock avalanches high on the dome that preceded the pyroclastic flows. Sounds of the colliding blocks within the pyroclastic flow avalanche are apparently muffled by the elutriating fine ash. 2. The Krafft's observed purple lightning flashes in the nuées but did not hear any thunderclaps. The compactness of the cauliflower cloud and observed lightning flashes lend credence to Perret's hypothesis that the dense clouds may be held together electrostatically (opposite charges of steam and ash). 3. The basal avalanche below the rolling cauliflower clouds moved in spurts. Its thickness was probably less than a few meters. 4. Forward-springing jets composed of relatively fine sand-sized material were clearly observed by Kienle at the snout of the avalanche. Jets or narrow sheets of this material emerged from the top surface of the moving basal avalanche and were thrown

Augustine Volcano (continued)

diagonally downwards ahead of the moving flow, immediately to be overrun by the following avalanche, suggesting that a retrograde rotor turbulence was operating at the flow front. 5. Occasionally, the basal avalanche would override and entrap a pocket of cold air behind an obstacle such as large rocks. Heating and expansion of the entrapped air caused sudden boils in the moving avalanche seconds later. 6. Meter-sized pumice blocks were seen emerging continuously from the flanks of the flows, leaving beautiful levees on the sides of the pyroclastic flow channels. 7. Where we observed the flows, they were eroding, leaving U-shaped channels 10-30 m wide with 2-m-high pumice levees on both sides. Some flows also left one or more central furrows. This suggests that longitudinal turbulent rolling motions occur within the pyroclastic flows. However, we could not observe this from our viewpoint to one side of the flows. 8. We did not notice any indraft adjacent to the pyroclastic flows, nor any incandescence, even at night, probably because they were relatively small. 9. Individual flows left a hot inflated gray fine ash deposit about 50 cm thick where we studied it at the 350 m level. 10. Larger pyroclastic flows on 28 August resulted in sand-sized ashfalls to the shoreline on the N and NW flanks. A large cloud produced by 2 merging pyroclastic flows passed overhead at the Burr Point camp (6 km N of the summit) at 1935, showering sand-sized particles on us for about 5 minutes. The sand was not hot.

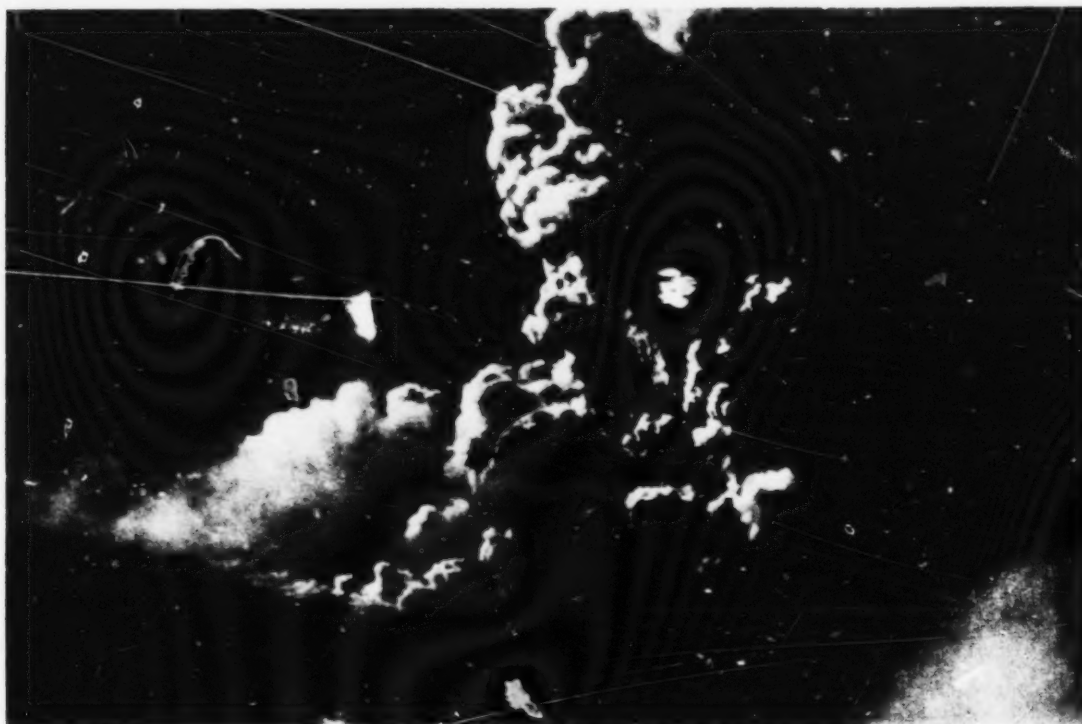


Figure 5: Pyroclastic flow at the 350 m level on the N flank of Augustine, 28 August. The flow probably originated at the base of the spine near the summit (about 1200 m level). At the moment shown, the flow had decelerated to about 20 m per second. No glow was observed in the flow, and its travel down the mountain was soundless to nearby witnesses. Foreground blocks are about 1 m in diameter. Photo by Juergen Kienle.

Augustine Volcano (continued)

"4. Dome Growth: Although we have no geodetic data, clear changes have taken place at the summit of the dome during this most recent eruptive episode. Miller and Kienle visited the crater on 11 September. A new spine, about 10 m high, occupied the small crater that had existed on top of the dome during the summer. Concentric ring fractures and alternating circles of moats and arches attest to endogenous dome growth and final extrusion of a spine above the central magma stem. New material was also added to the N face of the dome since we had last seen it on 17 July (see last month's Bulletin).

"5. Temperatures of March-April Pyroclastic Flows: These flows have cooled substantially since mid-July, when we recorded a maximum temperature of 525°C at 6.16 m depth on the NW flows. On 11 September, that hole had cooled to a maximum temperature of 270°C encountered at 4.55 m depth. Cooling is now taking place from the bottom and top of the deposits, with a temperature reversal below 4.55 m."

Information Contacts: Juergen Kienle and John Power, Geophysical Institute, University of Alaska, Fairbanks, AK 99775 USA; Maurice and Katia Krafft, Centre de Vulcanologie Vulcain, B.P. 5, 68700 Cernay, France; Thomas Miller, Branch of Alaskan Geology, USGS, 4200 University Drive, Anchorage, AK 99508 USA.

Pavlof Volcano, Alaska Peninsula, Alaska, USA (55.42°N, 161.90°W). All times are local (= GMT - 8 hours).

Airplane pilots frequently reported vapor and ash rising to 3.5-4 km altitude from Pavlof through 22 August (table 1). Sailors observed lava fountaining during the evening of 13 August, but airplane pilots generally do not fly close enough to the volcano to observe strombolian explosions and most flights are in daylight when eruptive glow is unlikely to be evident. No pilot reports of activity were received between 22 August and 8 September, although there was some clear weather during that period. On 8 September, vigorous vapor emission was observed from Sand Point, 90 km to the east. During an overflight on 12 September, only minor steaming was observed.

<u>Date</u>	<u>Time</u>	<u>Observer</u>	<u>Activity</u>
13 Aug.	evening	ASM	summit lava fountaining
14 Aug.	midday	GW	large white steam plume
18 Aug.	0850	PA	dark ash to 3600 m, drifting 80 km SE
18 Aug.	1047	SP	steam and ash plume to 4000m, drifting 55 km ESE
20 Aug.	1556	NOAA	ash plume to 3600 m, drifting SE
20 Aug.		JS	sound heard just before emission of large ash puff
21 Aug.	0900	TD & RS	plume alternating steam and ash at 3-minute intervals to 3000 m; visible for 15 minutes, then obscured by weather
22 Aug.	1152	RA	ash plume to 3600 m, drifting at least 16 km ESE
22 Aug.	1241	RA	occasional steam plumes
5 Sep.		SH	300-m dark nearly vertical column, drifting slightly NE
10 Sep.	1155	HB & AL	ash and steam to 3000 m, drifting NE 8 km
12 Sep.	1100	JC	minor steam emission from 100-m region near the summit
15 Sep.	1430	MB & CB	white steam from old N vent did not rise above summit

Table 1: Summary of reports collected by John Reeder. Observers: British sailors on the Ashley St. Mary; Flight Engineer George Wooliver, Reeve Aleutian Airways; Peninsula Airways; Sand Point Air; NOAA aircraft; Jean Shaul, Cold Bay; Theresa Dubber and Robert Senimore, FAA, Cold Bay; Reeve Aleutian Airways; Steve Hakala, Sand Point; Capts. Harold Black and Andy Livingston, Reeve Aleutian; Capt. Jerry Chisum, Markair; Marcia and Clayton Brown, Cold Bay.

Pavlof Volcano (continued)

Information Contacts: John Reeder, Alaska Division of Geological and Geophysical Surveys, P.O. Box 772116, Eagle River, AK 99577 USA; Thomas Miller, Branch of Alaskan Geology, USGS, 4200 University Drive, Anchorage, AK 99508 USA; John Taber, Lamont-Doherty Geological Observatory, Palisades, NY 10964 USA.

Shishaldin Volcano, Unimak Island, Aleutian Islands, Alaska, USA (54.75°N, 163.97°W). All times are local (= GMT - 8 hours).

Emission of large steam plumes, sometimes containing ash, were observed from aircraft and boats through August (table 2). Similar activity had been observed since mid-March (see SEAN Bulletin v. 11, no. 5).

<u>Date</u>	<u>Time</u>	<u>Observer</u>	<u>Activity</u>
30 June	1900	LG	white steam plume, drifting at least 5 km S
19 July	1430	LG	white steam plume with minor ash to 550 m above the summit, drifting more than 40 km E
mid-July		JC	steam with some ash drifted substantial distances
20 Aug.	1345	JCu	voluminous steam with traces of ash
21 Aug.	0900	TD & RS	450 m white plume drifting SSE
21 Aug.	afternoon	TK	white plume to at least 450 m above the summit, drifting S at least 16 km

Table 2: Summary of reports collected by John Reeder. Observers: Capt. Lee Goch, Reeve Aleutian Airways; Capt. Jerry Chisum, Markair; Jason Currier (on Markair flight); Theresa Dubber and Robert Senimore, FAA, Cold Bay; Tom Kizzia, Anchorage Daily News (aboard Alaska state ferry Tustumena).

Information Contact: John Reeder, Alaska Division of Geological and Geophysical Surveys, P.O. Box 772116, Eagle River, AK 99577 USA.

Akutan Volcano, E Aleutian Is., Alaska, USA (54.13°N, 166.00°W). All times are local (= GMT - 8 hours).

Strong plume emission, frequently including ash, has been reported since late December (see SEAN Bulletin v. 11, no. 5). On 30 June at 1840, Reeve Aleutian Airways Capt. Lee Goch saw gray-black ash emission from the active cinder cone within the caldera. Weather clouds just above the summit were discolored by the ash. Fresh-looking ash had been deposited on the upper N, NW, and W flanks. No additional reports of activity have been received since the end of June.

Information Contact: Same as for Shishaldin.

Mt. St. Helens Volcano, Cascade Range, S Washington, USA (46.20°N, 122.18°W).

Deformation, seismicity, and rates of SO₂ emission remained at background levels through early September. Deformation of the lava dome did not exceed 1-3 mm per day and no significant changes were detected by tiltmeters. SO₂ emission was measured at 55 ± 15 metric tons per day on 13 August and 35 ± 5 tpd on the 19th, normal values for periods between extrusion episodes. Seismicity also remained at background, with an approximately equal number of low-frequency and medium- to high-frequency events. Previous periods between extrusion episodes had generally been dominated by low-frequency seismicity.

Mt. St. Helens (continued)

A swarm of tiny earthquakes began late 12 September, with rates reaching 800-1000 events per day. Maximum focal depths were 2-3 km below the crater, and most were probably shallower. The swarm continued until the onset of seismicity characteristic of steam and ash emission at 0939 on 15 September. A white plume rose from the crater to about 3.5 km altitude, and the associated seismicity continued for about an hour. Seismicity then declined to background, although seismometers recorded another few minutes of apparent, but unwitnessed, gas emission starting at 2047 that evening. A tiltmeter on the W side of the dome indicated inflation for 1-2 days before the 15 September plume emission. This apparent inflationary tilt stopped after the morning plume emission, and no other tiltmeters or deformation measurements showed any significant changes.

Information Contacts: Donald Swanson and Steven Brantley, USGS Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, Washington 98661 USA; Chris Jonientz-Trisler, Geophysics Program, University of Washington, Seattle, Washington 98195 USA.

Kilauea Volcano, Hawaii, USA (19.42°N, 155.27°W).

Since January, recurrence intervals between the brief eruptive episodes had been very regular, ranging from 21-26 days, and activity had remained focused at the Pu'u O'o vent. This pattern changed with the onset of episode 48 on 18 July from new fissures uprift and downrift of Pu'u O'o (see last month's Bulletin). After 23 hours of quiet on 19 July, activity resumed from downrift fissures. This activity continued through August into mid-September, building a large shield about 3 km NE of Pu'u O'o.

By mid-September, the shield had grown to 1.5 km in diameter and 41 m high. Overflows filled low areas, and lava tubes fed short pahoehoe flows to its margin, with the longest flows extending only 2 km SE from the vent. Most of the shield was composed of pahoehoe flows but there was some aa lava at the margin. Upwelling was almost continuous from one or both of the two active vents, and low spattering has been occasionally observed. A lava pond had developed on the flat top of the shield by late August, and had grown to 100 m in diameter by 1 September (figure 6).

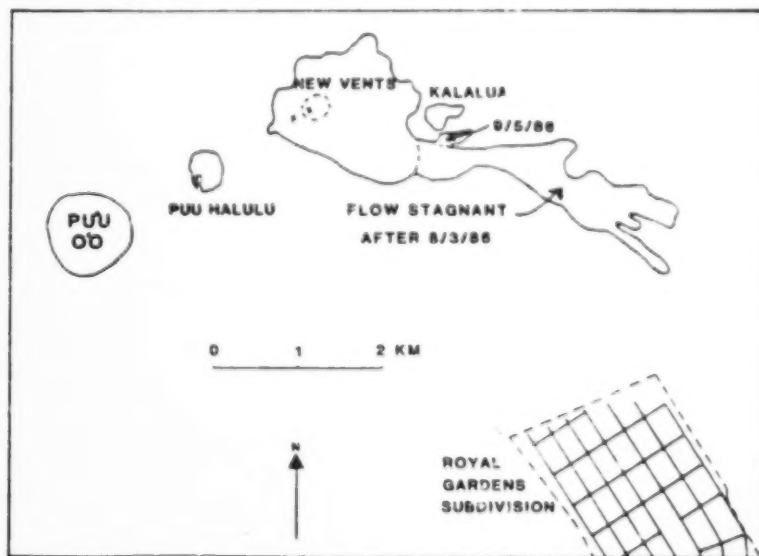


Figure 6: Sketch map of new eruptive vents, lava shield and flows on Kilauea's East Rift Zone.

Kilauea Volcano (continued)

Low-level tremor centered in the middle east rift zone continued with only slight changes in amplitude. Summit tilt remained unchanged through August (figure 7).

Pu'u O'o vent remained inactive, although the conduit was incandescent and there was a slight gas plume. The magma column that had been present in the conduit during past inter-phase periods was no longer visible.

Information Contact: Christina Heliker, USGS Hawaiian Volcano Observatory, P.O. Box 51, Hawaii National Park, Hawaii 96718 USA.

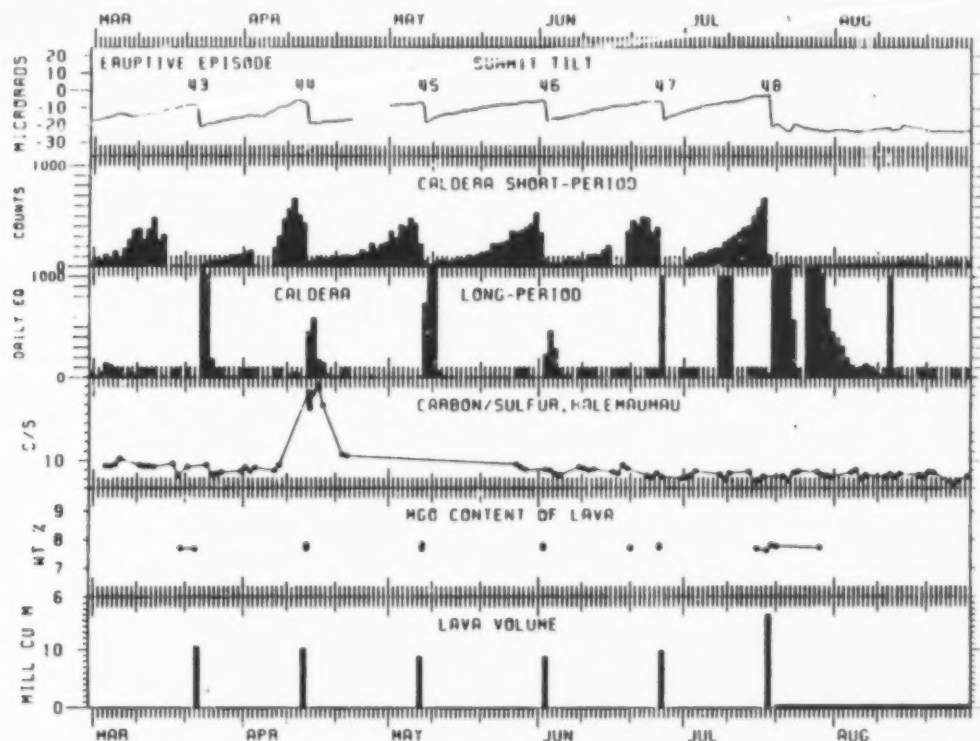


Figure 7: Six-month summary of Kilauea activity showing tilt, short- and long-period caldera earthquakes, carbon/sulfur ratio of summit gases, lava volumes, and the MgO content of lavas produced prior to and during major eruptive episodes. A substitute tiltmeter is currently in use as indicated by the break in the summit tilt curve.

Ruiz Volcano, Colombia (4.88°N, 75.37°W). All times are local (= GMT - 5 hours).

The following, from the Observatorio Vulcanológico Nacional, summarizes activity from 13 August to 12 September.

"No more strong ash emissions occurred after 29 July (see last month's Bulletin), although prolonged and weak emissions have been reported. We assume that the record of weak emissions is incomplete due to weather conditions and frequent snowfall.

"After a strong phase until about 20 August, the amplitude of harmonic tremor decreased, but tremor remained continuous and maintained 5 Hz as a dominant frequency. Occurrence of seismic events reached a minimum 17-23 August, with no events above the

Ruiz Volcano (continued)

tremor level for more than 40 hours. Seismicity then increased again, reaching a maximum of about 120 events on 9 September. During this maximum, several long-period events were recorded, quite similar to but smaller than those observed before November 1985. About half of the remaining events were of high frequency (A-type) and most of the rest were B-types.

"COSPEC measurements resumed on 15 August. Rates of SO₂ emission ranged between 500 and 12,000 metric tons per day, showing some correlation with tremor amplitude.

"The pattern of deformation changed in comparison to all previous months of 1986. By the end of August, most dry tilt stations began to show fluctuating changes, with amplitudes 2-4 times as large as those observed since December 1985. Cumulative resulting vectors pointed approximately to the summit area."

Information Contact: Hansjürgen Meyer, Director Científico, Observatorio Vulcanológico Nacional, INGEOMINAS, Apartado Aereo 1296, Manizales, Colombia.

Lascar Volcano, N Chile (23.37°S, 67.73°W). All times are local (= GMT - 4 hours).

Lascar erupted during the morning of 16 September. Strong winds deposited hypersthene andesite ash on the city of Salta, Argentina, 350 km to the SE.

Information Contacts: José Viramonte, Departamento de Geología, Universidad Nacional de Salta, 4400 Salta, Argentina; Telam News Service, Buenos Aires, Argentina.

Oshima Volcano, Izu Islands, Japan (34.73°N, 139.38°E).

On 20 July, Japan Meteorological Agency (JMA) seismic stations on Oshima Island began to record volcanic tremor for the first time in 12 years. Tremor, recorded regularly every 2 hours, continued through early September. Event durations were about 10-30 minutes and amplitude was about 0.5 microns at station A, which at 1 km NNW of the active summit cone (Mihara) is the nearest of the 5 JMA seismic stations. No significant change in the volcano's weak fumarolic activity was observed by field surveys in the crater on 1, 4, and 18 August.

A 10-hour earthquake swarm occurred during the morning of 21 August. Three of the events were felt at the weather station about 5 km NNW of the summit. As in previous episodes of seismicity, epicenters were on the N part of the island, 4-5 km NNE of the summit crater.

Oshima last erupted in 1974, with periods of weak strombolian activity between February and June. A decade of nearly continuous volcanic tremor ended that year and tremor had not been recorded since then. An earthquake swarm in the NW part of Oshima Island occurred October-November 1977 (see SEAN Bulletin v. 2, no. 11). Numerous earthquakes centered near the island were recorded in early 1983, and brief swarms of volcanic events occurred N and NW of the summit 31 May-1 June, 22 October, and 22 and 30-31 December, 1983 (Bulletin of Volcanic Eruptions no. 23, 1986).

Information Contact: Office of Volcanic Observations, Seismology and Volcanology Division, Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan.

Sakurajima Volcano, Kyushu, Japan (31.58°N, 130.67°E).

After 4 explosions were recorded in July (see last month's Bulletin), there were 22 explosions from the summit crater of Minamidake in August (table 3). The maximum plume height was 1800 m above the summit. Earthquake swarms, common at Sakurajima, occurred 2, 5, 11, 23, and 24 August.

TABLE 3

DATE: August	6	7	8	9	10	13	16	18	19	20	21	22	29	30	total
EXPLOSIONS	2	2	1	1	2	3	1	1	2	2	1	2	1	1	22

Information Contact: Same as for Oshima.

Volcanic Activity in Papua New Guinea

Rabaul Caldera, New Britain Island (4.27°S, 152.20°E).

"Seismicity at Rabaul returned to a low level in August, with 298 recorded events, compared to 1312 in July and 1570 in June (see last two Bulletins). The rate of earthquake occurrence varied between 3 and 23 events per day. Only 11 earthquakes were large enough to be located, and these were distributed in the Vulcan and Greet Harbour areas. Tilt and horizontal distance measurements indicated that rates of ground deformation were comparable to those preceding the 1983-5 crisis period."

Langila Volcano, New Britain Island (5.53°S, 148.42°E).

"Activity was very low in August. Emissions were limited to weak white vapours. There were no reports of incandescence or sounds from the summit, and seismicity was at a very low level."

Manam Volcano, off the N coast of New Guinea (4.10°S, 145.06°E).

"Activity remained at a low level throughout August. The main crater released weak white vapour emissions, while noiseless brown ash-laden emissions rose at intervals of a few minutes from the S crater. These resulted in very light ashfalls on the downwind side of the volcano on most days. Deep roaring noises were occasionally reported. Seismicity remained at an inter-eruptive level, about 1200 low-frequency small-amplitude events per day. No significant change was recorded by the Tabele water tube tiltmeters."

Bagana Volcano, Bougainville Island, Solomon Islands (6.14°S, 155.19°E).

"The phase of viscous lava extrusion from the summit crater continued into August at a moderate level as evidenced from visual observations and seismicity. Reports suggest that surges of lava into the active flow channel on the N flank took place on 6-7 and 31 August. White to brown emissions were usually quietly released from the crater, which was illuminated by a weak glow at night. Small explosions were reported 17-22 August. Rumbling noises were occasionally heard. Seismicity fluctuated throughout the month from 15 to 75 B-type events per day."

Information Contacts: Patrice de Saint Ours and C. O. McKee, Rabaul Volcano Observatory, P. O. Box 386, Rabaul, Papua New Guinea.

White Island Volcano, Bay of Plenty, New Zealand (37.52°S, 177.18°E).

New ash layers indicated that small-scale phreatomagmatic activity has continued intermittently since May 1986 from "Congress Vent", which became active in February within the 1978 Crater complex (see SEAN Bulletin v. 11, no. 2). During a 1 August visit, geologists examined the 1986 tephra, which can be subdivided into 3 units. Layer 1, accumulated since 27 July, was 18 mm thick at the sampling site on the 1978 Crater rim, 50 m E of the vent. It consisted mostly of submillimeter ash, containing altered lithic fragments and many subrounded crystals. Some angular chips of dark gray fresh andesite and minor brown volcanic glass were also present. Layer 2 was very widespread, extending over most of the main crater floor, and was 120 mm thick at the sampling site. It appeared to have been deposited while damp. The dispersal axis of this layer probably trends N to NW from the vent, and at least most of this layer was deposited since the last deformation survey, on 6 May. Layer 2 was similar to layer 1, but contained a larger proportion of more angular crystals and fresh andesite clasts, and less altered material. Layer 3, 155 mm thick at the sampling site, consisted of centimeter-bedded well-sorted very coarse gray ash and lapilli. Largely confined to within 50 m of the 1978 Crater rim, it was erupted in early 1986 and had formed the ground surface in early March.

Local volcanic seismicity since early May has been dominated by low-frequency (B-Type) volcanic earthquakes. The number of events ranged from 15 to more than 40 per day, and they appeared to have anomalously large amplitudes. High-frequency near-tectonic/volcano-tectonic events usually numbered less than 5 per day. Wide-band, long-duration volcanic earthquakes were recorded on 19, 26, and 30 June. An eruption column was reported by Geyserland Airways on 26 June.

The maximum temperature measured in the Donald Mound area (100 m E of the 1978 Crater rim) and the 1980 collapse pits to the NW was 665°C. Fumarole temperatures have generally declined in the Donald Mound area during the past 8 months but have risen in the 1980 collapse pits. Temperatures and pressures of a fumarole in the easternmost collapse pit were particularly high, and the 594°C measured was well below the true temperature. The vent walls appeared slightly incandescent.

After 2 1/2 years, the persistent NW-SE trough of subsidence centered on Donald Mound has been virtually eliminated except for a narrow moat to the south. There appeared to be no significant height change near the eastern edge of 1978 Crater associated with the 1986 Congress Vent.

Information Contact: B. J. Scott, New Zealand Geological Survey, P.O. Box 499, Rotorua, New Zealand.

Ruapehu Volcano, North Island, New Zealand (39.28°S, 175.57°E).

The crater lake had cooled 6.5°C per month since February, reaching 10.8°C by 31 July. Four similar periods of cooling have occurred during the last 6 years, 3 of them followed by minor hydrothermal eruptions 2-3 months later.

On 19 and 31 July, weak upwelling was occurring at the N end of the crater lake. Yellow sulfur slicks appeared to emanate from the northern vent area, with dark green slicks in the center of the lake. By the next visit, on 26 August, the lake temperature had risen to 14.5°C. Lake appearance was similar to that of late July, with some weak upwelling over the central vent.

Ruapehu Volcano (continued)

Deformation measurements on 31 July recorded only slight changes since the 8 May survey, including 13 mm of apparent shortening across the crater. Little additional change was measured 26 August.

Information Contacts: P. M. Otway, New Zealand Geological Survey, Wairakei, New Zealand; I. A. Nairn, New Zealand Geological Survey, P.O. Box 499, Rotorua, New Zealand.

Atmospheric Effects

Stratospheric aerosols from the November 1985 eruption of Ruiz persisted through August over Mauna Loa, Hawaii (19.5°N, 155.6°W) (table 4). The zone of enhanced lidar backscattering was distinctly broader and less intense than it had been several months earlier (figures 8 and 9). However, total backscatter has remained relatively stable since the arrival of Ruiz aerosols over Mauna Loa in late November. At Hampton, Virginia (37.1°N, 76.3°W), peak backscattering remained at about the same altitude as in June (see SEAN Bulletin v. 11, no. 6), but total backscatter had declined since late June.

LOCATION	DATE	TABLE 4 LAYER ALTITUDE IN KM (peak in parentheses)		BACKSCATTERING		
				COEFFICIENT	RATIO	INTEGRATED
Mauna Loa, Hawaii (19.5°N, 155.6°W)	5 Aug.	17-24	(20.7)	0.31×10^{-7}	1.8	0.17×10^{-3}
			(23.1)	0.15×10^{-7}	1.6	
	15 Aug.	16-23.5	(21.6)	0.31×10^{-7}	2.0	0.19×10^{-3}
	19 Aug.	16-22.5	(19.5)	0.22×10^{-7}	1.5	0.15×10^{-3}
			(21.3)	0.20×10^{-7}	1.6	
	27 Aug.	17-23.5	(21.9)	0.19×10^{-7}	1.6	0.13×10^{-3}
Hampton, Virginia (37.1°N, 76.3°W)	26 Aug.	13.5-26.5 (19.4)			1.3	0.10×10^{-3}
SAGE II Support Mission 41.3°N, 105.7°W	29 July	13-25.5	(18.6)		1.2	0.08×10^{-3}

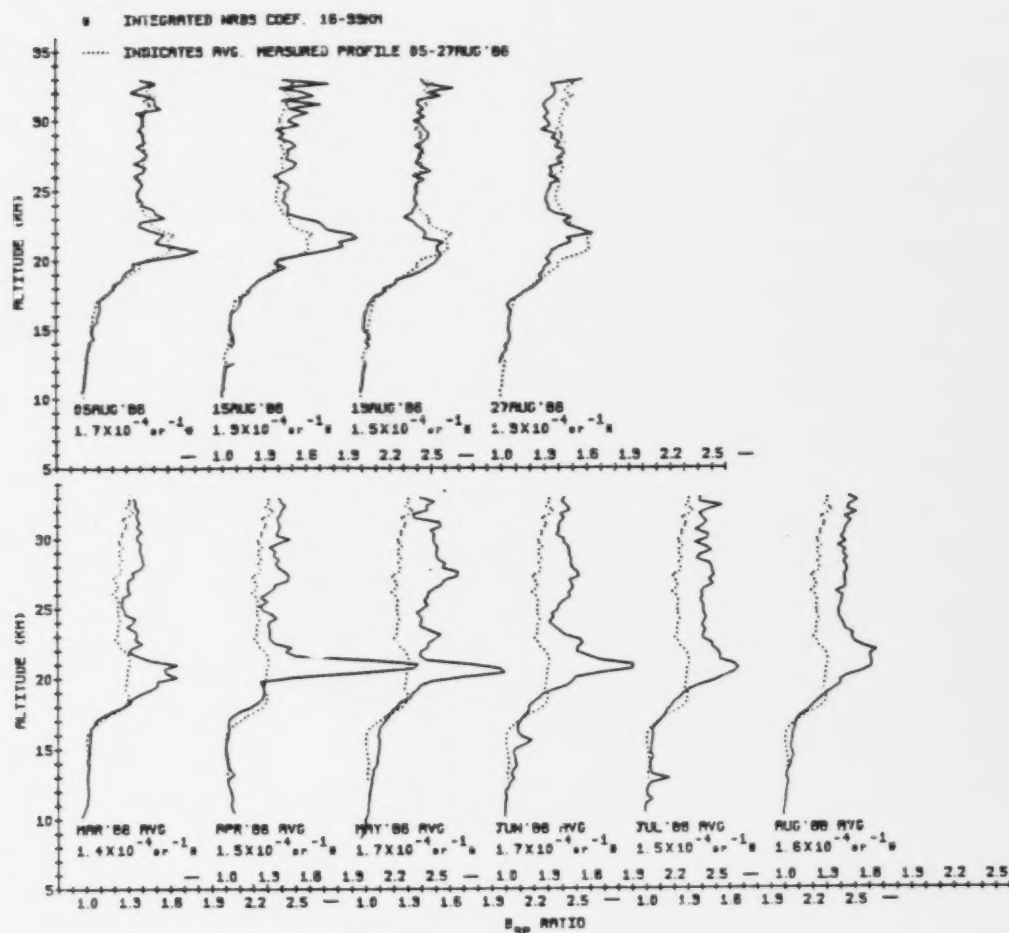
Table 4: Lidar data from various locations, showing altitudes of aerosol layers. Note that some layers have multiple peaks. Backscattering ratios are for the ruby wavelength of 0.69 microns. Altitudes of maximum backscattering ratios and coefficients are shown for each layer at Mauna Loa. Integrated values show total backscatter, expressed in steradians⁻¹, integrated over 300-m intervals from 16-33 km at Mauna Loa and from the tropopause to 30 km at Hampton and on the SAGE II Support Mission. Integrated values have been calculated for one site on the SAGE II mission, supplementing data in last month's Bulletin.

Information Contacts: Thomas DeFoor, Mauna Loa Observatory, P.O. Box 275, Hilo, Hawaii 96720 USA; William Fuller, NASA Langley Research Center, Hampton, Virginia 23665 USA.

Figure 8 (next page, top): Lidar profiles from Mauna Loa, Hawaii, 5-27 August. The dotted line superimposed on each profile represents the average August data.

Figure 9 (next page, bottom): Average monthly lidar profiles at Mauna Loa, Hawaii, March-August, 1986. The dotted line superimposed on each profile represents the average 5-22 November 1985 data, before the arrival of Ruiz aerosols.

Atmospheric Effects (continued)



EARTHQUAKES

DATE	TIME (GMT)	MAGNITUDE	LAT.	LONG.	DEPTH OF FOCUS	REGION
3 August	0133	5.0 m _b	37.14°N	37.30°E	10 km	Turkey
14 August	1939	7.4 M _S	2.05°N	126.64°E	33 km	Molucca Sea
21 August	2123	6.5 M _S	34.50°N	91.51°E	33 km	China/Tibet
26 August	0943	6.0 M _S	37.75°N	101.58°E	33 km	China/Tibet
30 August	2128	6.9 M _S	45.55°N	26.26°E	143 km	Romania/USSR

The earthquake in Turkey was felt from Gaziantep to Malatya and caused damage to 70 houses in Yesilce, Ucgöze, and Sam villages and 3 houses in Pazarcik, but no injuries were reported.

The earthquake in the Molucca Sea was felt to Intensity IV in Manado City but no damages were reported and no tsunami warning was issued.

The China-Tibet border region is sparsely populated and no damages or injuries were reported after the 21 August temblor.

Some damage to houses in the Gansu and Qinghai Provinces was reported following the China/Tibet border earthquake of 26 August.

EARTHQUAKES (continued)

Two people died and 558 others were injured in Moldavia as a result of the earthquake on 30 August. Widespread damage to more than 50,000 structures including schools, apartment buildings, and houses was reported. More than 12,500 were left homeless. The epicenter was 150 km N of Bucharest, Romania and was felt from Naples, Italy, to Moscow, USSR, 3000 km apart.

Correction: In the May SEAN Bulletin, the tsunamis generated by the 7 May earthquake were erroneously reported. The correct figures are: up to 1.2 m in Hawaii, and up to 91 cm in Washington. The British Columbia tsunami height was in error but no corrected value is available.

Information Contacts: National Earthquake Information Service, U. S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA; Associated Press; United Press International; TASS.

FIREBALLS

Argentina, 17 July, 0100-0200 GMT
(16 July, 2200-2300 local time)
Observer: Jose W. Soroka
Location: 15 km N of Córdoba City
(31.25°S, 64.11°W)
Path: E to W, alt 30°
Last sighting: near 10° above horizon
Duration: 2 seconds
Color: White
Magnitude: -5 to -7
Termination: No fragments were seen
Sounds: None

Argentina, 18 July, 0130 GMT
(17 July, 2230 local time)
Observer: Jose W. Scroka
Location: 15 km N of Córdoba City
(31.25°S, 64.11°W)
Path: E to W, alt. about 10°
Last sighting: Disappeared below horizon
Duration: 3-4 seconds
Color: White
Magnitude: -5 to -7
Sounds: None

Information contact: Maximiliano Rocca, Corrientes 4299, Buenos Aires - Capital Federal 1195, Argentina.

S. Australia, 30 July, 1930 GMT (31 July, 0500 local time)
Observers: Cpt. P. Jones, F/O G. Chapman
Qantas Airways, flt. QF82-292
Location: 31.02°S, 132.0°E, alt. 12.5 km
1st Sighting: Azimuth 188°, alt. 10-15°
Last Sighting: Azimuth 188°, alt. 10-15°
Path: Parallel to horizon
Duration: 2 seconds
Apparent velocity: Fast
Magnitude: Dazzling
Trail: Apparent smoke for 5 seconds
Information contact: G. Polnitzky, Universitaets-Sternwarte, Tuerkenschanzstrasse 17, A-1180 Vienna, Austria.

Austria, 22 August, 1915 GMT
(2115 local time)
Observer: Helmut F. Haar
Location: Ilz, Styria
1st sighting: Near Theta Herculis
Last sighting: Near Gamma Sagittari
Path: Descending along R.A. 18^h10^m
Duration: 6 seconds
Apparent velocity: Slow
Magnitude: Brighter than Venus
Tail: Small
Termination: Disappeared above horizon
Information contact: H. Mucke, Astronomisches Büro, Hasenwartgasse 32, A-1238 Vienna, Austria.

FIREBALLS (continued)

W. Canada, 4 September, 0834 GMT
(0134 local time)

Observers: Summary of reports from several people
Location: 100 km NW of Vancouver, B.C.
1st Sighting: Azimuth 250°, alt. 45°
Last Sighting: Azimuth 020°, alt. 03°
Duration: 7-10 seconds
Apparent velocity: Slow
Magnitude: -5 to -7
Color: Straw yellow
Termination: Red sparks as it burst twice then faded as it approached horizon
Information contact: David Dodge, Gordon Southam Obs., 1100 Chestnut Street, Vancouver, B.C. V6J3J9, Canada.

Madagascar, 31 July, 2103 GMT
(1 August, 0003 local time)

Observers: Cpt. C. Murray, S/O M. O'Toole, E/O D. Caldwell, Qantas Airways, flt QF 24, Harare-Perth
Location: 18.20°S, 45.47°E, alt. 10 km
1st Sighting: 111° Azimuth, alt. 60°
Last Sighting: 101° Azimuth, alt. 5°
Duration: 2 seconds
Apparent velocity: Fast
Magnitude: Bright as full moon
Color: Blue-white
Trail: 1 second afterglow
Information contact: G. Polnitzky, Universitaets-Sternwarte, Muekkenschanzstrasse 17, A-1180 Vienna, Austria.

California, USA. 5 September 1150 GMT
(0450 Pacific Daylight Time)

Observer: Jeff Martoff
Location: Woodside, San Mateo County
Path: W to E, downward at shallow angle, from 25° alt. to 10° alt.
Duration: 1-2 seconds
Apparent velocity: Fast
Magnitude: Bright as full moon
Color: Green
Termination: Flared brightly, fragmented into $\pm$ 10 pieces, faded above horizon
Information contact: J. Martoff, 9 Orchard Hill Dr., Woodside, CA. 94062

Italy, 3 September, 2105 GMT
(2005 local time)

Location: Rome, (41.53°N, 12.30°E)
Path: S to N
Duration: Several seconds
Magnitude: Very bright
Trail: Blue trail
Termination: Left a few fragments before disappearing in partially sunset sky
Information contact: La Stampa, Torino; Luigi Mancini, P. O. Box 3319, Falls Church, VA 22043 USA.

California, 20 August, 1430 GMT
(2130 local time)

Observers: Suzy Gurton, Gene Hertell, 2 reports from separate locations
Location: Los Angeles (34.00°N, 118.15°W)
Path: NE to N, downward at steep angle
Duration: 2-3 seconds
Apparent velocity: Medium
Magnitude: Brighter than Venus
Color: Began dim yellow, brightened to white/blue/green
Trail: 1) Luminous, yellow 2) sparks
Termination: Passed out of view while still bright
Information contact: Griffith Observatory, 2800 E. Observatory Rd., Los Angeles, CA 90027.

New York, USA. 9 September 0257 GMT
(2257 Eastern Daylight Time)

Observers: 1) P. Ackerman, 2) R. Somer
Location: 1) Endicott Co., 2) Clinton Co.
1st Sighting: Azim. 310°, dec. +15
Last Sighting: Azim. 315°, dec. -30
Duration: 1) 7 seconds, 2) >3 seconds
Apparent velocity: Fast
Magnitude: Beginning -12, ending -7
Color: 1) Blue/white, 2) Green
Trail: 15° to 20° long, luminous
Termination: Fragmented, 2-5 pieces
Information contact: P. Ackerman, 14 Canterbury Dr., Endicott, NY 13760; R. Somer, 9 Miller Rd., Clinton, NY 13323.

FIREBALLS (continued)

Oregon, USA. 3 August 0518 GMT

Many people in Oregon saw a large fireball on the night of 2 August from different counties. Their combined reports are given below:

Location:	Multnomah	Clackamas	Benton
1st Sighting:	Azim. 120° alt. 45°	Azim. 180° alt. 40°	Azim. 80° alt. 60°
Last sighting:	Azim. 290° alt. 30°	Azim. 210° alt. 15°	Azim. 255° alt. 80°
Descent angle:	10°	40°	0°, passed overhead
Duration:	4 seconds	2 seconds	3 seconds
Magnitude:	3 x brighter than Venus	Brighter than full moon	Brighter than full moon
Shape, Size:	Round with tail	Round, full moon,	Round, full moon
Color:	White, white tail	Silver white	Blue/green-white,
Trail:	Full length of path	No tail reported	Full length of path
Termination:	Became brighter at end, vanished above horizon	Faded out, vanished above horizon	Grew larger, brighter as it passed overhead had moving shadow
Sound:	No sounds were heard by observers, and no breakup was seen.		

Oregon, USA. 1 August, 0840 GMT
(0140 Pacific Daylight Time)

Observer: Chris Benson
Location: Benton Co. (44.55°N, 123.26°W)
1st sighting: Zenith, alt. 90°
Last sighting: Azim. 0°, alt. 60°
Path: Downward at 60° angle
Duration: 2 seconds
Size: 1 1/4 x full moon, pear-shaped
Magnitude: Brighter than full moon
Color: Yellow/blue
Tail: Blue, 20° long
Termination: Flared brightly at end, vanished above horizon

Oregon, USA. 8 August, 0615 GMT (7 August
2315 Pacific Daylight Time)

Observer: Chuck Selby
Location: Lake Co. (43.2°N, 120.68°W)
1st sighting: Azim. 75°, alt. 70°
Last sighting: Azim. 105°, alt. 70°
Path: Parallel to horizon
Duration: 4 seconds
Size: Diameter of full moon, round
Magnitude: Brighter than full moon
Color: Yellow-white
Tail: Yellow-white, 20° long, 5° wide with pulsating bright spots
Termination: Vanished above horizon

Oregon, USA. 8 August 0434 GMT (7
August, 2134 Pacific Daylight Time)

Observer: David Osgood
Location: Deschutes Co. (W of Sun River)
1st sighting: Azim. 60°, alt. 50°
Last sighting: Azim. 120°, alt. 30°
Path: Downward at 20° angle
Duration: 1.5 seconds
Size: 1/2 diameter of full moon, round
Magnitude: Brighter than full moon
Color: Yellow/white
Tail: Yellow/white, 30° long
Termination: Became brighter as it descended, vanished behind trees

Oregon, USA. 9 August, 0550 GMT (8
August, 2250 Pacific Daylight Time)

Observer: Chuck Selby
Location: Lake Co. (43.2°N, 120.68°W)
1st sighting: Azim. 160°, alt. 75°
Last sighting: Azim. 160°, alt. 10°
Path: Downward at 90°
Duration: 3 seconds
Size: 1 1/4 x full moon, pear-shaped
Magnitude: Brighter than full moon
Color: Yellow-white
Tail: No tail, but sparks fell away from head
Termination: Passed below horizon

Information contact: Richard Pugh, 4617 NE 26th Avenue, Portland, Oregon 97211.

FIREBALLS (continued)

Rhode Island, USA. 8 September 0630 GMT,
(0230 Eastern Daylight Time)

Observer: Robert Matthews

Location: Kent Co. (41.42°N, 71.38°W)

Path: WSW downward at about 80° angle

Duration: 2 seconds

Size: 1/6 size of full moon

Magnitude: Not as bright as full moon

Color: White flash changed to yellow/green

Tail: Yellowish, 5° long, blue underneath

Termination: Disappeared below tree line

Information contact: Robert Matthews,
43 Topping John Ln. Rt. 4, Box 3271,
Coventry, Rhode Island 02816.

Wyoming, USA. 16 August, 0308 GMT, (15
August, 2108 Mountain Daylight Time)

Observer: Tom Phillips

Location: Bridger National Forest

Path: NE to NW downward at 30° angle

Duration: 3-4 seconds

Size: 1/4 size of full moon

Magnitude: Not as bright as full moon

Color: Orangish/red

Tail: Luminous yellow/orange 5° long

Termination: Flickered out above trees

Information contact: Tom Phillips,
6106 S. Adams Dr., Littleton,
Colorado 80121.